## Q. No. 1 – 25 Carry One Mark Each

1. Roots of the algebraic equation $x^3 + x^2 + x + 1 = 0$ are

(A) $(+1, +j, -j)$ (B) $(+1, -1, +1)$ (C) $(0,0,0)$ (D) $(-1, +j, -j)$

Answer: - (D)

Exp: - $x^3 + x^2 + x + 1 = 0 \Rightarrow (x^2 + 1)(x + 1) = 0 \quad \Rightarrow x + 1 = 0;\ x^2 + 1 = 0 \quad \Rightarrow x = -1 \quad x = \pm j$

2. With K as a constant, the possible solution for the first order differential equation $\frac{dy}{dx} = e^{-3x}$ is

(A) $-\frac{1}{3}e^{-3x} + K$ (B) $-\frac{1}{3}e^{3x} + K$ (C) $-\frac{1}{3}e^{-3x} + K$ (D) $-3e^{-x} + K$

Answer: - (A)

Exp: - $\frac{dy}{dx} = e^{-3x} \Rightarrow dy = e^{-3x}dx$

Integrate on both sides

$$y = \frac{e^{-3x}}{-3} + K = -\frac{1}{3}e^{-3x} + K$$

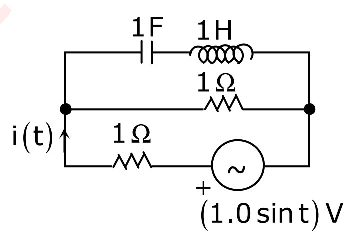
3. The r.m.s value of the current i(t) in the circuit shown below is

(A) $\frac{1}{2}$A

(B) $\frac{1}{\sqrt{2}}$A

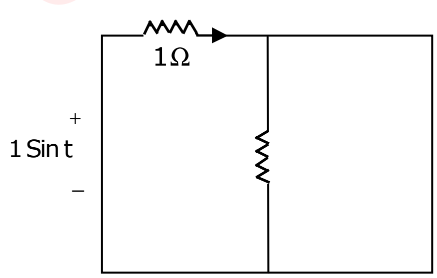
(C) 1A

(D) $\sqrt{2}$A




Answer: - (B)

Exp: - $\omega = 1$ rad/sec $\quad X_L = 1\Omega; \quad X_C = 1\Omega$




$$I(t) = \frac{\text{Sin } t}{1\Omega} = \text{Sin } t;\ I_{rms} = \frac{1}{\sqrt{2}}A$$

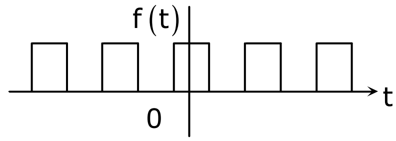
4. The fourier series expansion $f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos n\omega t + b_n \sin n\omega t$ of the periodic signal shown below will contain the following nonzero terms

(A) $a_0$ and $b_n$, $n = 1,3,5,...\infty$

(B) $a_0$ and $a_n$, $n = 1,2,3,...\infty$

(C) $a_0$ $a_n$ and $b_n$, $n = 1,2,3,...\infty$

(D) $a_0$ and $a_n$ $n = 1,3,5,...\infty$




Answer: - (D)

Exp: - $\Rightarrow$ it satisfies the half wave symmetry, so that it contains only odd harmonics.

$\Rightarrow$ It satisfies the even symmetry. So $b_n = 0$

5. A 4 – point starter is used to start and control the speed of a

(A) dc shunt motor with armature resistance control

(B) dc shunt motor with field weakening control

(C) dc series motor

(D) dc compound motor

Answer: - (A)

6. A three-phase, salient pole synchronous motor is connected to an infinite bus. Ig is operated at no load a normal excitation. The field excitation of the motor is first reduced to zero and then increased in reverse direction gradually. Then the armature current

(A) Increases continuously

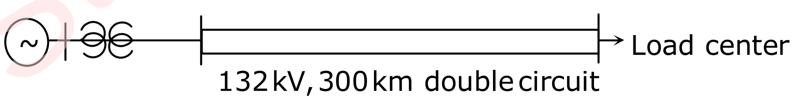
(B) First increases and then decreases steeply

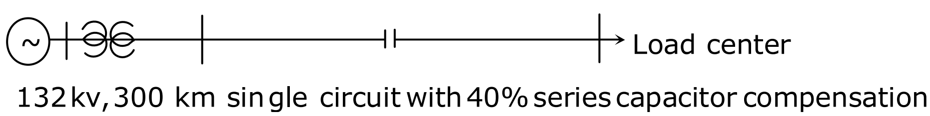
(C) First decreases and then increases steeply

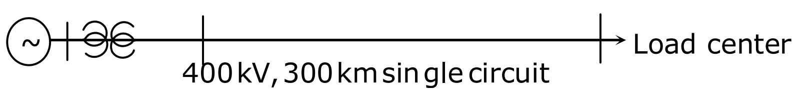
(D) Remains constant

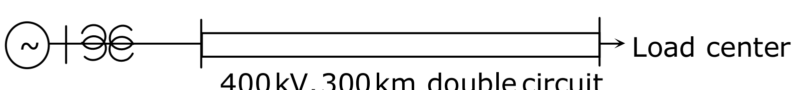
Answer: - (B)

7. A nuclear power station of 500 MW capacity is located at 300 km away from a load center. Select the most suitable power evacuation transmission configuration among the following options

(A)



(B)



(C)



(D)



Answer: - (A)

8. The frequency response of a linear system $G(j\omega)$ is provided in the tubular form below

| $\lvert G(j\omega)\rvert$ | 1.3 | 1.2 | 1.0 | 0.8 | 0.5 | 0.3 |
|---|---|---|---|---|---|---|
| $\angle G(j\omega)$ | $-130^o$ | $-140^o$ | $-150^o$ | $-160^o$ | $-180^o$ | $-200^o$ |

(A) 6 dB and $30^o$ (B) 6 dB and $-30^o$

(C) $-6$ dB and $30^o$ (D) $-6$ dB and $-30^o$

Answer: - (A)

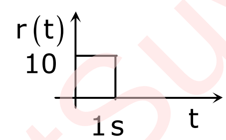
Exp: - At $\angle G(jw) = -180$ magnitude M=0.5

So G.M = 20 log $\left(\frac{1}{0.5}\right) = 6dB$

At $\lvert G(jw)\rvert = 1$ phase angle $\angle G(jw) = -150$

So P.M = $180 + (-150) = 30^0$

9. The steady state error of a unity feedback linear system for a unit step input is 0.1. The steady state error of the same system, for a pulse input r(t) having a magnitude of 10 and a duration of one second, as shown in the figure is




(A) 0 (B) 0.1 (C) 1 (D) 10

Answer: - (A)

Exp: - For step input $e_{ss} = 0.1 = \frac{1}{1+k} \Rightarrow k = 9$

$$G(S) = \frac{9}{S+1}$$

Now the input is pulse $r(t) = 10\left[u(t) - u(t-1)\right]$

$$r(s) = 10\left[\frac{1-e^{-s}}{s}\right]$$

$$e_{ss} = \underset{S\to 0}{Lt} \frac{S.R(s)}{1+G(S)H(S)} = \underset{S\to 0}{Lt} \frac{\frac{S\ 10\left[1-e^{-s}\right]}{S}}{\frac{S+10}{S+1}} = \frac{0}{10} = 0$$

10. Consider the following statement

(i) The compensating coil of a low power factor wattmeter compensates the effect of the impedance of the current coil.

(ii) The compensating coil of a low power factor wattmeter compensates the effect 0of the impedance of the voltage coil circuit.

(A) (i) is true but (ii) is false (B) (i) is false but (ii) is true
(C) both (i) and (ii) are true (D) both (i) and (ii) are false

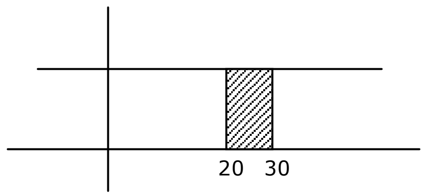
Answer: - (B)

11. A low – pass filter with a cut-off frequency of 30Hz is cascaded with a high-pass filter with a cut-off frequency of 20Hz. The resultant system of filters will function as

(A) an all-pass filter (B) an all-stop filter
(B) an band stop (band-reject) filter (D) a band – pass filter

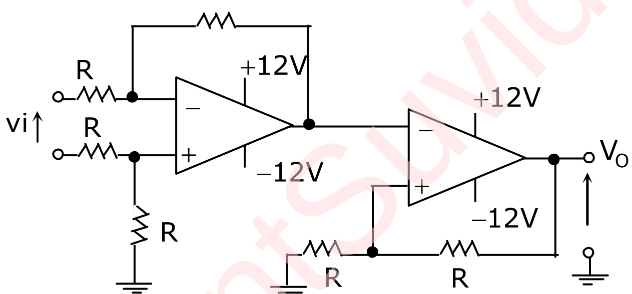
Answer: - (D)

Exp: -



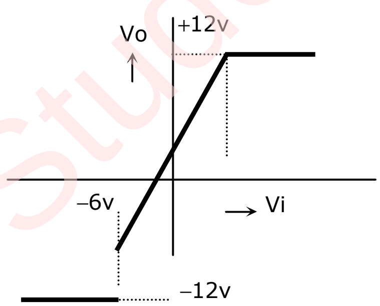

So it is a band pass filter

12.

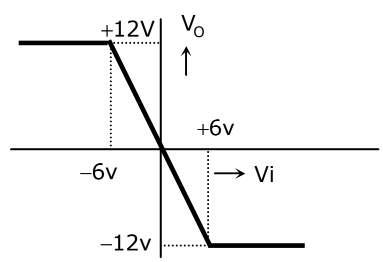



The **CORRECT** transfer characteristic is

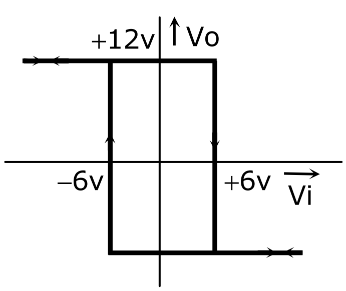
(A)



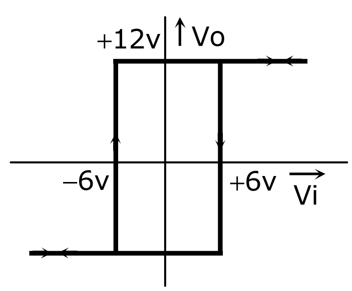

(B)




(C)



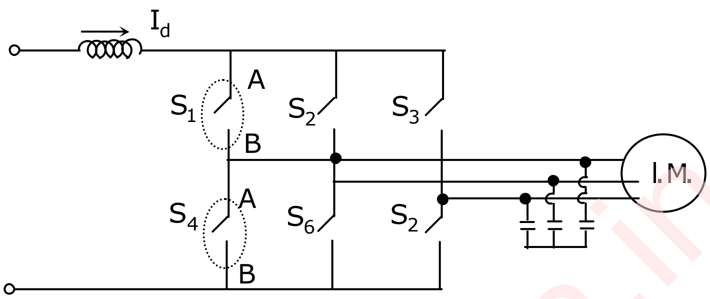

(D)



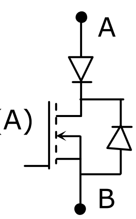
Answer: - (D)

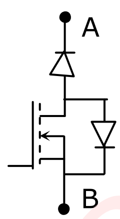
Exp: - It is a Schmitt trigger and phase shift is zero.

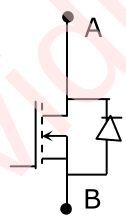
13. A three-phase current source inverter used for the speed control of an induction motor is to be realized using MOSFET switches as shown below. Switches $S_1$ to $S_6$ are identical switches.

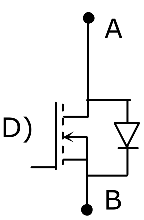



The proper configuration for realizing switches $S_1$ to $S_6$ is

(A)


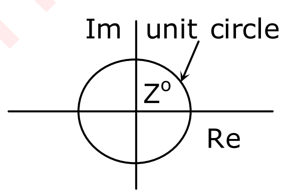

(B)



(C)


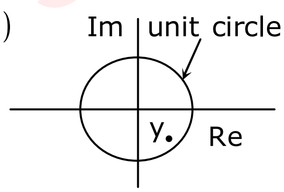

(D)


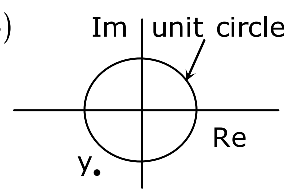

Answer: - (C)

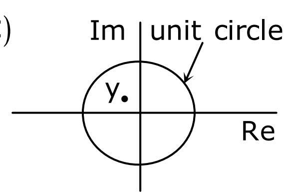
14. A point Z has been plotted in the complex plane, as shown in figure below.

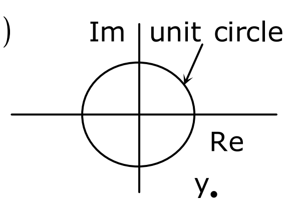



The plot of the complex number $y = \frac{1}{z}$ is

(A)



(B)



(C)



(D)


Answer: - (D)

Exp: - $|Z| < 1$, so $|Y| > 1$

Z is having +ve real part and positive imaginary part ($\therefore$ from the characteristics)
So Y should have +ve real part and negative imaginary part.

15. The voltage applied to a circuit is $100\sqrt{2}\ \cos\ (100\pi t)$ volts and the circuit draws a current of $10\sqrt{2}\ \sin\ (100\pi t + \pi/4)$ amperes. Taking the voltage as the reference phasor, the phasor representation of the current in amperes is

(A) $10\sqrt{2}\ \angle -\pi/4$ (B) $10\ \angle -\pi/4$

(C) $10\ \angle +\pi/4$ (D) $10\sqrt{2}\angle +\pi/4$

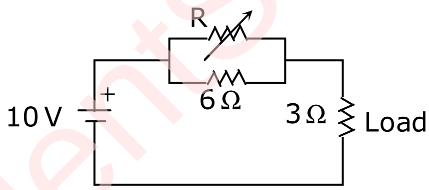
Answer: - (B)

Exp: - $V(t) = 100\sqrt{2}\cos(100\pi t)$

$$i(t) = 10\sqrt{2}\ \sin\left(100\pi t + \frac{\pi}{4} + \frac{\pi}{2} - \frac{\pi}{2}\right) = 10\sqrt{2}\cos\left(100\pi t - \frac{\pi}{4}\right)$$

$$\text{So } I = \frac{10\sqrt{2}}{\sqrt{2}}\angle -\frac{\pi}{4} = 10\angle -\frac{\pi}{4}$$

16. In the circuit given below, the value of R required for the transfer of maximum power to the load having a resistance of $3\Omega$ is




(A) zero (B) $3\Omega$ (C) $6\Omega$ (D) infinity

Answer: - (A)

Exp: - $R = 0 :\ P_{max} = \frac{10^2}{3}$ $(\because R_L = \text{constant})$

17. Given two continuous time signals $x(t) = e^{-t}$ and $y(t) = e^{-2t}$ which exist for t > 0, the convolution z(t) = x(t)* y(t) is

(A) $e^{-t} - e^{-2t}$ (B) $e^{-3t}$ (C) $e^{+t}$ (D) $e^{-t} + e^{-2t}$

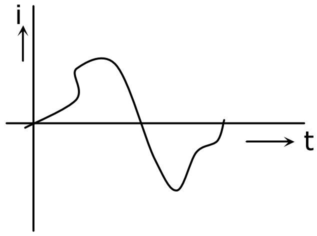
Answer: - (A)

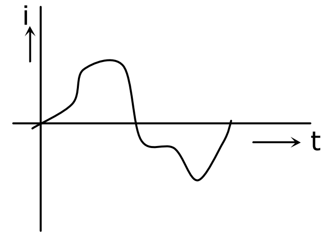
Exp: - $z(t) = x(t) * y(t)$

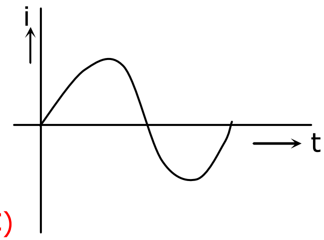
$$z(s) = x(s).y(s) = \frac{1}{(s+1)}.\frac{1}{(s+2)} = \frac{1}{(s+1)} - \frac{1}{(s+2)}$$

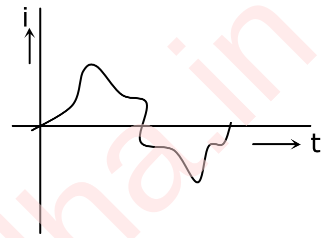
$$L^{-1}\{z(s)\} = z(t) = e^{-t} - e^{-2t}$$

18. A single phase air core transformer, fed from a rated sinusoidal supply, is operating at no load. The steady state magnetizing current drawn by the transformer from the supply will have the waveform

(A)



(B)



(C)



(D)



Answer: - (C)

Exp: - It is an air core transformer. So, there is no saturation effect.

19. A negative sequence relay is commonly used to protect

(A) an alternator
(B) an transformer
(C) a transmission line
(D) a bus bar

Answer: - (A)

20. For enhancing the power transmission in along EHV transmission line, the most preferred method is to connect a

(A) Series inductive compensator in the line
(B) Shunt inductive compensator at the receiving end
(C) Series capacitive compensator in the line
(D) Shunt capacitive compensator at the sending end

Answer: - (C)

Exp: - $P \alpha \frac{1}{X}$ Where, $X = (X_L - X_c)$

21. An open loop system represented by the transfer function $G(s) = \frac{(s-1)}{(s+2)(s+3)}$ is

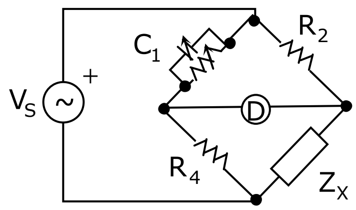
(A) Stable and of the minimum phase type
(B) Stable and of the non - minimum phase type
(C) Unstable and of the minimum phase type
(D) Unstable and of non-minimum phase type

Answer: - (B)

Exp: - Open loop system stability is depends only on pole locations $\Rightarrow$ system is stable

There is one zero on right half of s-plane so system is non – minimum phase

22. The bridge circuit shown in the figure below is used for the measurement of an unknown element ZX. The bridge circuit is best suited when $Z_X$ is a




(A) low resistance
(C) high resistance
(A) low Q inductor
(B) lossy capacitor

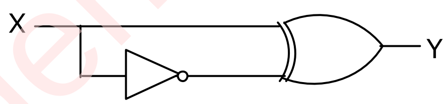
Answer: - (C)

23. A dual trace oscilloscope is set to operate in the ALTernate mode. The control input of the multiplexer used in the y-circuit is fed with a signal having a frequency equal to

(A) the highest frequency that the multiplexer can operate properly
(B) twice the frequency of the time base (sweep) oscillator
(C) the frequency of the time base (sweep) oscillator
(D) haif the frequency of the time base (sweep) oscillator

Answer: - (C)

24. The output Y of the logic circuit given below is




(A) 1 (B) 0 (C) X (D) $\bar{X}$

Answer: - (A)

Exp: - $y = x.\bar{\bar{x}} + \bar{x}.\bar{x} = x + \bar{x} = 1$

**Q. No. 26 – 51 Carry Two Marks Each**

25. Circuit turn-off time of an SCR is defined as the time

(A) taken by the SCR turn of
(B) required for the SCR current to become zero
(C) for which the SCR is reverse biased by the commutation circuit
(D) for which the SCR is reverse biased to reduce its current below the holding current

Answer: - (C)

26. Solution of the variables $x_1$ and $x_2$ for the following equations is to be obtained by employing the Newton-Raphson iterative method.

equation (i) $10x_2 \sin x_1 - 0.8 = 0$

equation (ii) $10x_2^2 - 10x_2 \cos x_1 - 0.6 = 0$

Assuming the initial valued $x_1 = 0.0$ and $x_2 = 1.0$, the jacobian matrix is

(A) $\begin{bmatrix} 10 & -0.8 \\ 0 & -0.6 \end{bmatrix}$ (B) $\begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$

(C) $\begin{bmatrix} 0 & -0.8 \\ 10 & -0.6 \end{bmatrix}$ (D) $\begin{bmatrix} 10 & 0 \\ 10 & -10 \end{bmatrix}$

Answer: - (B)

Exp: - $10x_2 \sin x_1 - 0.5 = 0$ ....(i)

$10x_2^2 - 10x_2 \cos x_1 - 0.6 = 0$ ...(ii)

$$J = \begin{bmatrix} \frac{\partial (i)}{\partial x_1} & \frac{\partial (i)}{\partial x_2} \\ \frac{\partial (ii)}{\partial x_1} & \frac{\partial (ii)}{\partial x_2} \end{bmatrix} \text{ at } x_1 = 0 \text{ and } x_2 = 1 \quad J = \begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$$

27. The function $f(x) = 2x - x^2 - x^3 + 3$ has

(A) a maxima at x = 1 and minimum at x = 5

(B) a maxima at x = 1 and minimum at x = -5

(C) only maxima at x = 1 and

(D) only a minimum at x = 5

Answer: - (C)

Exp: - $f(x) = 2x - x^2 + 3$

$f'(x) = 0 \Rightarrow 2 - 2x = 0 \Rightarrow x = 1$

$f''(x) = -2 \Rightarrow f''(x) < 0$

So the equation f(x) having only maxima at x =1

28. A lossy capacitor $C_x$, rated for operation at 5 kV, 50 Hz is represented by an equivalent circuit with an ideal capacitor $C_p$ in parallel with a resistor $R_P$. The value $C_p$ is found to be 0.102 $\mu$F and the value of $R_p$ = 1.25 M$\Omega$. Then the power loss and tan $\partial$ of the lossy capacitor operating at the rated voltage, respectively, are

(A) 10 W and 0.0002 (B) 10 W and 0.0025

(C) 20 W and 0.025 (D) 20 W and 0.04

Answer: - (C)

29. Let the Laplace transform of a function F(t) which exists for t > 0 be $F_1(s)$ and the Laplace transform of its delayed version $f(1-\tau)$ be $F_2(s)$. Let $F_1*(s)$ be the complex conjugate of $F_1(s)$ with the Laplace variable set as $s=\sigma+jw$. If G(s) = $\frac{F_2(s).F_1*(s)}{|F_1(s)|^2}$, then the inverse Laplace transform of G(s) is

(A) An ideal impulse $\delta(t)$

(B) An ideal delayed impulse $\delta(t-\tau)$

(C) An ideal step function $u(t)$

(D) An ideal delayed step function $u(t-\tau)$

Answer: - (B)

Exp: -$F_2(t) = L\{f(t-\tau)\} = e^{-ST}F_1(S)$

$$G(S) = \frac{e^{-s\tau}F_1(s).F_1^*(s)}{|F_1(s)|^2} = e^{-s\tau}$$

$$G(t) = L^{-1}\{G(S)\} = \delta(t-\tau)$$

30. A zero mean random signal is uniformly distributed between limits –a and +a and its mean square value is equal to its variance. Then the r.m.s value of the signal is

(A) $\frac{a}{\sqrt{3}}$ (B) $\frac{a}{\sqrt{2}}$ (C) $a\sqrt{2}$ (D) $a\sqrt{3}$

Answer: - (A)

Exp: - Variance$=\frac{(a-(-a))^2}{12}=\frac{4a^2}{12}=\frac{a^2}{3}$; R.M.S value $=\sqrt{\text{variance}}=\frac{a}{\sqrt{3}}$

31. A 220 V, DC shunt motor is operating at a speed of 1440 rpm. The armature resistance is $1.0\Omega$ and armature current is 10A. of the excitation of the machine is reduced by 10%, the extra resistance to be put in the armature circuit to maintain the same speed and torque will be

(A) 1.79 $\Omega$ (B) 2.1 $\Omega$ (C) 18.9 $\Omega$ (D) 3.1 $\Omega$

Answer: - (A)

Exp: -$I_{a1} = 10$

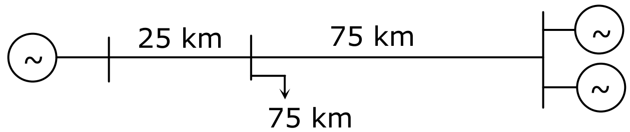
Now flux is decreased by 10%, so $\phi_2 = 0.9\phi_1$

Torque is constant so $I_{a1}\phi_1 = I_{a2}\phi_2 \Rightarrow I_{a2} = \frac{10}{0.9} = 11.11A$

$$N\alpha\, E_b/\phi \Rightarrow \frac{N_1}{N_2} = \frac{E_{b1}}{E_{b2}}\times\frac{\phi_2}{\phi_1} = \frac{220-I_{a1}r_1}{220-I_{a2}(r_1+R)}\times\frac{0.9\phi_1}{\phi_1}$$

$$1 = \frac{210\times0.9}{220-11.11(1+R)} \Rightarrow 1+R = 2.79 \Rightarrow R = 1.79\Omega$$

32. A load center of 120MW derives power from two power stations connected by 220kV transmission lines of 25km and 75km as shown in the figure below. The three generators G1,G2 and G3 are of 100MW capacity each and have identical fuel cost characteristics. The minimum loss generation schedule for supplying the 120 MW load is




(A) $P1 = 80MW + \text{losses}$, $P2 = 20MW$, $P3 = 20MW$

(B) $P1 = 60MW$, $P2 = 30MW + \text{losses}$, $P3 = 30MW$

(C) $P1 = 40MW$, $P2 = 40MW$, $P3 = 40MW + \text{losses}$

(D) $P1 = 30MW + \text{losses}$, $P2 = 45MW$, $P3 = 45MW$

Answer: - (A)

Exp: - $\text{Loss} \, \alpha \, p^2$ ; $\text{Loss} \, \alpha$ length

For checking all options only option A gives less losses.

33. The open loop transfer function G(s) of a unity feedback control system is given as

$$G(s) = \frac{k\left(s + \frac{2}{3}\right)}{s^2(s+2)}$$

From the root locus, it can be inferred that when k tends to positive infinity,

(A) Three roots with nearly equal real parts exist on the left half of the s-plane

(B) One real root is found on the right half of the s-plane

(C) The root loci cross the $j\omega$ axis for a finite value of k ; $k \neq 0$

(D) Three real roots are found on the right half of the s-plane

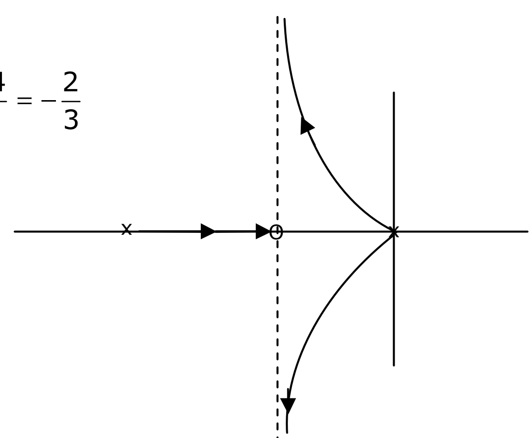
Answer: - (A)

Exp: - Centroid $\sigma = \frac{-2 - \left(-\frac{2}{3}\right)}{3 - 1} = \frac{-6+2}{6} = \frac{-4}{6} = -\frac{2}{3}$

Asymptotes $= \frac{(29 \pm 1)180}{p - z}$

$\theta_1 = \frac{180}{2} = 90$

$\theta_2 = \frac{18 \times 3}{2} = 270^0$



34. A portion of the main program to call a subroutine SUB in an 8085 environment is given below.

:

:

LXI D,DISP

LP : CALL SUB

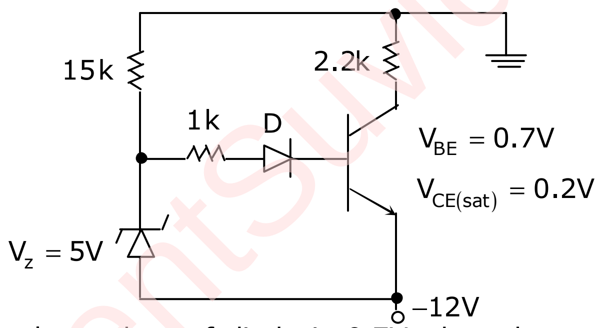
:

It is desired that control be returned to LP+DISP+3 when the RET instruction is executed in the subroutine. The set of instructions that precede the RET instruction in the subroutine are

| (A) | (B) | (C) | (D) |
|---|---|---|---|
| POP D<br>DAD H<br>PUSH D | POP H<br>DAD D<br>INX H<br>INX H<br>INX H<br>PUSH H | POP H<br>DAD D<br>PUSH H | XTHL<br>INX D<br>INX D<br>INX D<br>XTHL |

Answer: - (C)

35. The transistor used in the circuit shown below has a $\beta$ of 30 and $I_{CBO}$ is negligible




If the forward voltage drop of diode is 0.7V, then the current through collector will be

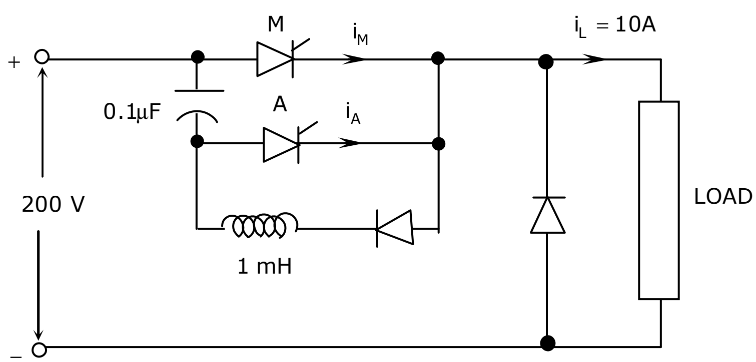
(A) 168 mA (B) 108 mA (C) 20.54mA (D) 5.36 mA

Answer: - (D)

Exp: - Transistor is in Saturation region

$$I_C = \frac{12 - 0.2}{2.2K} = 5.36\,mA$$

36. A voltage commutated chopper circuit, operated at 500Hz, is shown below.



If the maximum value of load current is 10A, then the maximum current through the main (M) and auxiliary (A) thyristors will be

(A) $i_{M\max} = 12\,A$ and $i_{A\max} = 10\,A$ (B) $i_{M\max} = 12\,A$ and $i_{A\max} = 2\,A$

(C) $i_{M\max} = 10\,A$ and $i_{A\max} = 12\,A$ (D) $i_{M\max} = 10\,A$ and $i_{A\max} = 8\,A$

Answer: - (A)

Exp: - $i_{M\max} = I_o + I_{C_{peak}} = I_o + V_S\sqrt{\frac{C}{L}} = 10 + 200\sqrt{\frac{0.1\mu}{1m}} = 12A$

$i_{A\max} = I_o = 10A$

37. The matrix $[A] = \begin{bmatrix} 2 & 1 \\ 4 & -1 \end{bmatrix}$ is decomposed into a product of a lower triangular matrix [L] and an upper triangular matrix [U]. The properly decomposed [L] and [U] matrices respectively are

(A) $\begin{bmatrix} 1 & 0 \\ 4 & -1 \end{bmatrix}$ and $\begin{bmatrix} 1 & 1 \\ 0 & -2 \end{bmatrix}$ (B) $\begin{bmatrix} 2 & 0 \\ 4 & -1 \end{bmatrix}$ and $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} 1 & 0 \\ 4 & 1 \end{bmatrix}$ and $\begin{bmatrix} 2 & 1 \\ 0 & -1 \end{bmatrix}$ (D) $\begin{bmatrix} 2 & 0 \\ 4 & -3 \end{bmatrix}$ and $\begin{bmatrix} 1 & 1.5 \\ 0 & 1 \end{bmatrix}$

Answer: - (D)

Exp: - $[A] = [L][U] \Rightarrow$ Option D is correct

38. The two vectors [1,1,1] and $[1, a, a^2]$, where $a = \left(-\frac{1}{2} + j\frac{\sqrt{3}}{2}\right)$, are

(A) Orthonormal (B) Orthogonal (C) Parallel (D) Collinear

Answer: - (B)

Exp: - Dot product of two vectors $= 1 + a + a^2 = 0$

So orthogonal

39. A three –phase 440V, 6 pole, 50Hz, squirrel cage induction motor is running at a slip of 5%. The speed of stator magnetic field to rotor magnetic field and speed of rotor with respect to stator magnetic field are

(A) zero, - 5 rpm (B) zero, 955 rpm

(C) 1000rpm, -5rpm (D) 1000rpm, 955rpm

Exp: $N_S = \frac{120 \times f}{P} = \frac{120 \times 50}{6} = 1000$ rpm ; Rotor speed $= N_S - SN_S = 950$ r.p.m

Stator magnetic field speed $= N_S = 1000$ r.p.m

Rotor magnetic field speed $= N_S = 1000$ r.p.m

Relative speed between stator and rotor magnetic fields is zero

Rotor speed with respect to stator magnetic field is $= 950 - 1000 = -50$ r.p.m

40. A capacitor is made with a polymeric dielectric having an $\varepsilon_r$ of 2.26 and a dielectric breakdown strength of 50kV/cm. The permittivity of free space is 8.85pF/m. If the rectangular plates of the capacitor have a width of 20cm and a length of 40cm, then the maximum electric charge in the capacitor is

(A) 2μC (B) 4μC (C) 8μC (D) 10μC

Answer: - (C)

Exp:- $q = CV = \frac{\varepsilon.A}{d} \times V = \varepsilon.A\left(\frac{V}{d}\right) = \varepsilon_r \varepsilon_0 A \times E = 2.26 \times 8.85 \times 10^{-14} \times 50 \times 10^{3} \times 20 \times 40 = 8\mu c$

41. The response h(t) of a linear time invariant system to an impulse $\delta(t)$, under initially relaxed condition is $h(t) = e^{-t} + e^{-2t}$. The response of this system for a unit step input u(t) is

(A) $u(t) + e^{-t} + e^{-2t}$ (B) $\left(e^{-t} + e^{-2t}\right)u(t)$ (C) $\left(1.5 - e^{-t} - 0.5e^{-2t}\right)u(t)$

(D) $e^{-1}\delta(t) + e^{-2t}u(t)$

Answer: - (C)

Exp: - L (Impulse response) = T.F $= \frac{1}{(S+1)} + \frac{1}{(S+2)}$

Step response $= L^{-1}\left[\frac{1}{S(S+1)} + \frac{1}{S(S+2)}\right] = L^{-1}\left[\left(\frac{1}{S} - \frac{1}{S+1}\right) + \left(\frac{0.5}{S} - \frac{0.5}{(S+2)}\right)\right]$

$$= \left(1 - e^{-t} + 0.5 - 0.5e^{-2t}\right)u(t)$$

$$= \left(1.5 - e^{-t} - 0.5e^{-2t}\right)u(t)$$

42. The direct axis and quadrature axis reactance's of a salient pole alternator are 1.2p.u and 1.0p.u respectively. The armature resistance is negligible. If this alternator is delivering rated kVA at upf and at rated voltage then its power angle is

(A) $30^0$ (B) $45^0$ (C) $60^0$ (D) $90^0$

Answer: - (B)

Exp: - $\tan\delta = \frac{I_a\left(x_q \cos\theta + r_a \sin\theta\right)}{V_t + I_a\left(x_q \sin\theta - r_a \cos\theta\right)}$

$I_a = 1$ p.u; $V_t = 1$ p.u   $\theta =$ Power factor angle $= 0^0$

$x_d = 1.2$p.u; $x_q = 1$.p.u ; $r_a = 0$

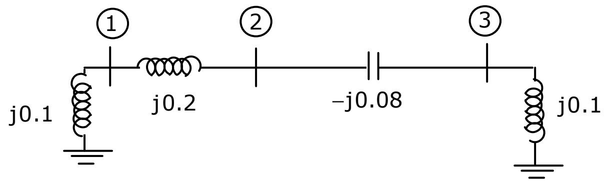
$\tan\delta = 1 \Rightarrow \delta = 45^0$

43. A 4½ digit DMM has the error specification as : 0.2% of reading + 10 counts. If a dc voltage of 100V is read on its 200V full scale, the maximum error that can be expected in the reading is

(A) ±0.1% (B) ±0.2% (C) ±0.3% (D) ±0.4%

Answer: - (C)

44. A three – bus network is shown in the figure below indicating the p.u. impedances of each element.




The bus admittance matrix, Y – bus, of the network is

(A) $j\begin{bmatrix} 0.3 & -0.2 & 0 \\ -0.2 & 0.12 & 0.08 \\ 0 & 0.08 & 0.02 \end{bmatrix}$ (B) $j\begin{bmatrix} -15 & 5 & 0 \\ 5 & 7.5 & -12.5 \\ 0 & -12.5 & 2.5 \end{bmatrix}$

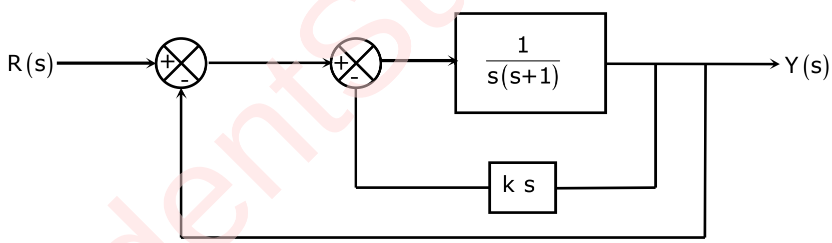
(C) $j\begin{bmatrix} 0.1 & 0.2 & 0 \\ 0.2 & 0.12 & -0.08 \\ 0 & -0.08 & 0.10 \end{bmatrix}$ (D) $j\begin{bmatrix} -10 & 5 & 0 \\ 5 & 7.5 & 12.5 \\ 0 & 12.5 & -10 \end{bmatrix}$

Answer: - (B)

EXP:-

$$Y_{11} = \frac{1}{j0.1} + \frac{1}{j0.2} = -j15$$

45. A two loop position control system is shown below




The gain k of the Tacho-generator influences mainly the

(A) Peak overshoot

(B) Natural frequency of oscillation

(C) Phase shift of the closed loop transfer function at very low frequencies $(\omega \to 0)$

(D) Phase shift of the closed loop transfer function at very low frequencies $(\omega \to \infty)$

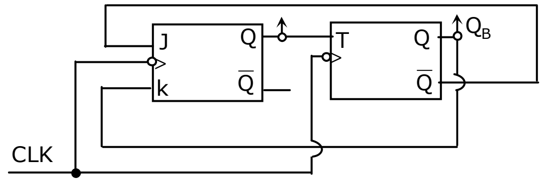
Answer: - (A)

EXP:-

$$\frac{Y(S)}{R(S)} = \frac{1}{S^2 + (k+1)S + 1}$$

$2\xi w_n = k + 1 \Rightarrow \xi = \left(\frac{k+1}{2}\right)$; Peak over shoot $= e^{-\pi\xi/\left(1-\xi^2\right)}$

46. A two – bit counter circuit is shown below




It the state $Q_AQ_B$ of the counter at the clock time $t_n$ is '10' then the state $Q_AQ_B$ of the counter at $t_n + 3$ (after three clock cycles ) will be

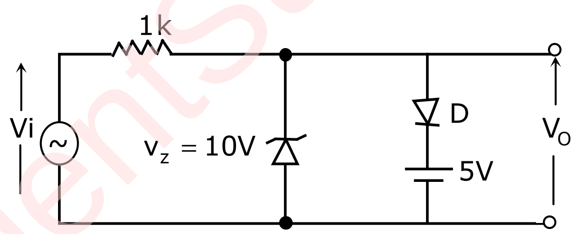
(A) 00 (B) 01 (C) 10 (D) 11

Answer: - (C)

EXP:-

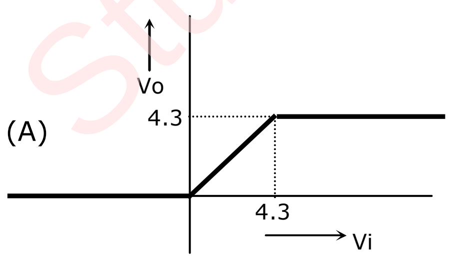
| Clock | Input | | | Output | |
|---|---|---|---|---|---|
| | $J_A=\overline{Q_B}$ | $K_A=Q_B$ | $T_B= Q_A$ | $Q_A$ | $Q_B$ |
| Initial state | | | | 1 | 0 |
| 1 | 1 | 0 | 1 | 1 | 1 |
| 2 | 0 | 1 | 1 | 0 | 0 |
| 3 | 1 | 0 | 0 | **1** | **0** |

47. A clipper circuit is shown below.

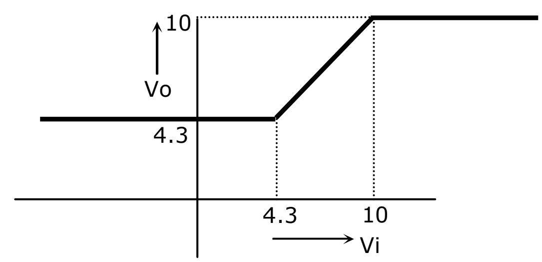



Assuming forward voltage drops of the diodes to be 0.7V, the input-output transfer characteristics of the circuit is

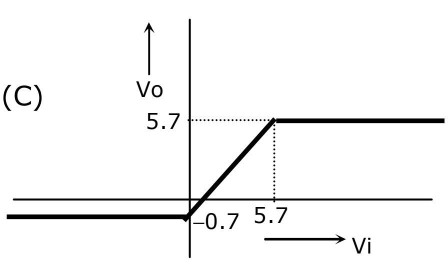
(A)



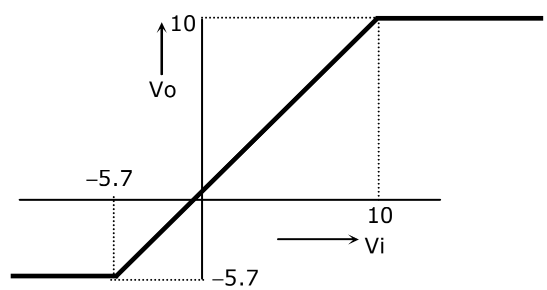

(B)




(C)




(D)



Answer: - (C)

Exp:

When $-0.7V < V_i < 5.7V$ output will follow input, because zener diode and normal diodes are off

When $V_i \le -0.7V$ Zener diode forward bias and $V_0 = -0.7\,V$

When $V_i \ge 5.7V$ Diode is forward bias and $V_0 = 5.7\,V$

**Common Data Questions: 48 & 49**

The input voltage given to a converter is

$v_i = 100\sqrt{2}\ \sin\ (100\pi t)\ V$

The current drawn by the converter is

$i_i = 10\sqrt{2}\ \sin\ (100\pi t - \pi/3) + 5\sqrt{2}\ \sin(300\pi t + \pi/4) + 2\sqrt{2}\sin(500\pi t - \pi/6)\,A$

48. The input power factor of the converter is

(A) 0.31 (B) 0.44 (C) 0.5 (D) 0.71

Answer: - (C)

Exp: - Input power factor is depends on fundamental components

$$V(t) = 100\sqrt{2}\sin(100\pi t)\,V;\ \ I(t) = 10\sqrt{2}\sin\left(100\pi t - \frac{\pi}{3}\right)$$

$$\cos\phi = \cos\frac{\pi}{3} = 0.5$$

49. The active power drawn by the converter is

(A) 181 W (B) 500 W (C) 707 W (D) 887 W

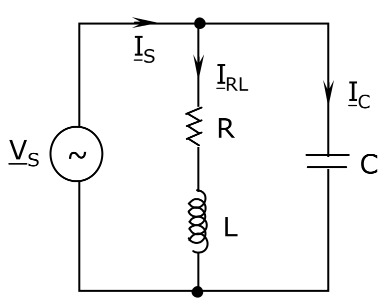
Answer: - (B)

Exp: -$P = V_{1(r.m.s)}I_{1(r.m.s)}\cos\theta_1 + V_{3,rms}I_{3,rms}\cos(\theta_3) + V_{5,rms}I_{5,rms}\cos(\theta_5)$

$$V_{3,rms} = 0\ ;\ V_{5,rms} = 0;\qquad P = V_{1,rms}I_{1,rms}\cos(\theta_1) = 100\times 10\cos\left(\frac{\pi}{3}\right) = 500\,\text{Watts}$$

**Common Data Questions: 50 & 51**

An RLC circuit with relevant data is given below.




$\underline{V}_S = 1\angle 0V$

(D) 94 A

$\underline{I}_{RL} = \sqrt{2}\ \angle -\pi/4\,A$

50. The power dissipated in the resistor R is

(A) 0.5 W (B) 1 W (C) $\sqrt{2}$ W (D) 2 W

Answer: - (B)

Exp: - Total power delivered by the source = power dissipated in 'R'

$$P = VI\cos\theta = 1\times\sqrt{2}\cos\left(\frac{\pi}{4}\right) = 1W$$

51. The current Ic in the figure above is

(D) $-j2$ A (B) $-j\frac{1}{\sqrt{2}}$ A (C) $+j\frac{1}{\sqrt{2}}$ A (D) $+j2$A

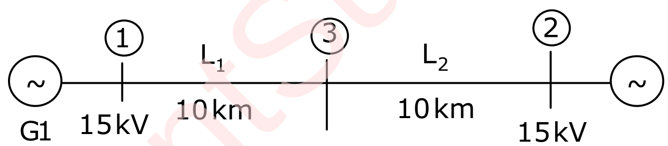
Answer: - (D)

Exp: - $I_C = I_S - I_{RL} = \sqrt{2}\angle\frac{\pi}{4} - \sqrt{2}\angle-\frac{\pi}{4} = j2A$

**Linked Answer Questions: Q.52 to Q.55 Carry Two Marks Each**

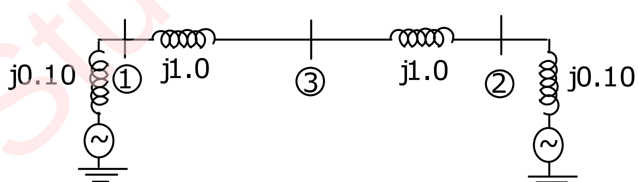
**Statement for Linked Answer Questions: 52 & 53**

Two generator units G1 and G2 are connected by 15 kV line with a bus at the mid-point as shown below.

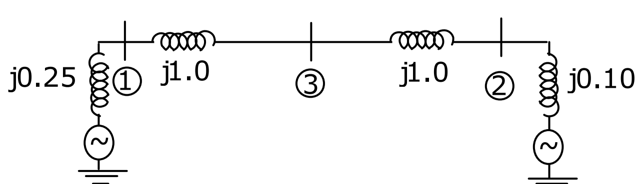



G1 = 250 MVA, 15kV, positive sequence reactance X = 25% on its own base
G2 = 100 MVA, 15kV, positive sequence reactance X = 10 % on its own base
$L_1$ and $L_2$ = 10km, positive sequence reactance X = 0.225 $\Omega$/km

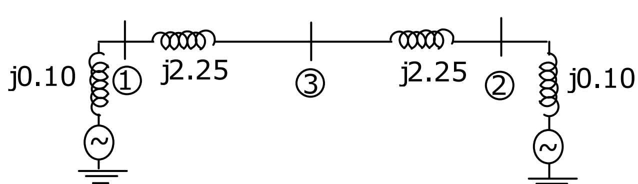
(A)

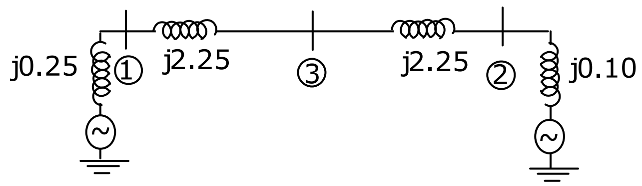



(B)




(C)



(D) 


Answer: - (A)

Exp: - $X_{L1} = 0.225 \times 10 = 2.25\Omega$

$X_{L2} = 0.225 \times 10 = 2.25\Omega$

Take 100 MVA s 15 kV as base

**For generator (G1)**

$$X_{g1} = 0.25 \times \frac{100}{25} = 0.1\,p.u$$

**For Transmission Line (L1 and L2)**

$$Z_{Base} = \frac{(15)^2}{100} = 2.25\Omega$$

$$XT_{L1}\,(p.u) = \frac{2.25}{2.25} = 1\,p.u$$

$$XT_{L2}\,(p.u) = 1\,p.u$$

**For generator (G2)**

$$X_{g2}\,(p.u) = 0.1 \times \left(\frac{100}{100}\right) = 0.1\ p.u$$

53. In the above system, the three-phase fault MVA at the bus 3 is

(A) 82.55 MVA (B) 85.11 MVA (C) 170.91 MVA (D) 181.82 MVA

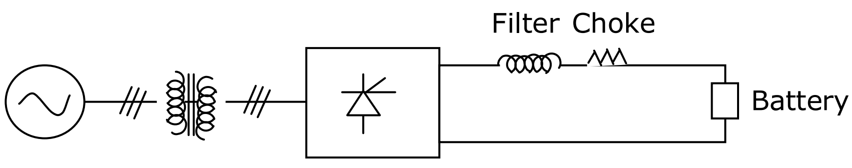
Answer: - (A)

Exp: - $X_{Th1} = 1.1 \,||\, 1.1 = 0.55$

$$\text{Fault (MVA)} = \frac{\text{Base MVA}}{\text{fault Thevenin's Impedance}} = \frac{100}{0.55} = 181.82\,\text{MVA}$$

**Statement for Linked Answer Questions: 54 & 55**

A solar energy installation utilize a three – phase bridge converter to feed energy into power system through a transformer of 400V/400 V, as shown below.




The energy is collected in a bank of 400 V battery and is connected to converter through a large filter choke of resistance $10\Omega$.

54. The maximum current through the battery will be

(A) 14 A (B) 40 A (C) 80 A (D) 94 A

Answer: - (A)

Exp: - $V_0 = I_a r_a + E$

$$(V_0)_{max} = \frac{3\sqrt{6}V_{phase}}{\pi} \quad (\because \cos\alpha = 1)$$

$$= I_a r_a + E$$

$$540.2 = I_a(10) + 400$$

$$I_a = 14A$$

55. The kVA rating of the input transformer is

(A) 53.2 kVA (B) 46.0 kVA (C) 22.6 kVA 3

Answer: -

Exp: - KVA rating $= \sqrt{3}V_L I_L = \sqrt{3}V_L \frac{\sqrt{6}}{\pi} I_o = \sqrt{3} \times 400 \times \frac{\sqrt{6}}{\pi} \times 14 = 7562VA$

**Q. No. 56 – 60 Carry One Mark Each**

56. There are two candidates P and Q in an election. During the campaign, 40% of the voters promised to vote for P, and rest for Q. However, on the day of election 15% of the voters went back on their promise to vote for P and instead voted for Q. 25% of the voters went back on their promise to vote for Q and instead voted for P. Suppose, P lost by 2 votes, then what was the total number of voters?

(A) 100 (B) 110 (C) 90 (D) 95

Answer: - (A)

Exp: -

| P | Q |
|---|---|
| 40% | 60% |
| –6% | +6% |
| +15% | –15% |
| 49% | 51% |

$\therefore 2\% = 2$

$100\% = 100$

57. Choose the most appropriate word from the options given below to complete the following sentence:

**It was her view that the country's problems had been__________ by foreign technocrats, so that to invite them to come back would be counter-productive.**

(A) Identified (B) ascertained (C) Texacerbated (D) Analysed

Answer: - (C)

Exp: -The clues in the question are ---foreign technocrats did something negatively to the problems – so it is counter-productive to invite them. All other options are non-negative. The best choice is exacerbated which means aggravated or worsened.

58. Choose the word from the options given below that is most nearly opposite in meaning to the given word:

**Frequency**

(A) periodicity (B) rarity

(C) gradualness (D) persistency

Answer: - (B)

Exp: - The best antonym here is rarity which means shortage or scarcity.

59. Choose the most appropriate word from the options given below to complete the following sentence: **Under ethical guidelines recently adopted by the Indian Medical Association, human genes are to be manipulated only to correct diseases for which________________ treatments are unsatisfactory.**

(A) Similar (B) Most (C) Uncommon (D) Available

Answer: - (D)

Exp: - The context seeks to take a deviation only when the existing/present/current/ alternative treatments are unsatisfactory. So the word for the blank should be a close synonym of existing/present/current/alternative. Available is the closest of all.

60. The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair:

**Gladiator : Arena**

(A) dancer : stage (B) commuter: train

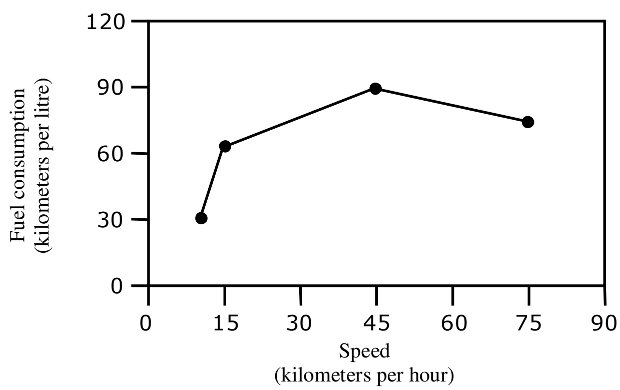
(C) teacher : classroom (D) lawyer : courtroom

Answer: - (D)

Exp: - The given relationship is worker: workplace. A gladiator is (i) a person, usually a professional combatant trained to entertain the public by engaging in mortal combat with another person or a wild.(ii) A person engaged in a controversy or debate, especially in public.

**Q. No. 61 – 65 Carry Two Marks Each**

61 The fuel consumed by a motorcycle during a journey while traveling at various speeds is indicated in the graph below.



The distances covered during four laps of the journey are listed in the table below

| Lap | Distance (kilometers) | Average speed (kilometers per hour) |
|---|---|---|
| P | 15 | 15 |
| Q | 75 | 45 |
| R | 40 | 75 |
| S | 10 | 10 |

From the given data, we can conclude that the fuel consumed per kilometre was least during the lap

(A) P (B) Q (C) R (D) S

Answer: - (A)

Exp: - Fuel consumption Actual

| | Fuel consumption | Actual |
|---|---|---|
| P | $60\,km/l$ | $\frac{15}{60}=\frac{1}{4}l$ |
| Q | $90\,km/l$ | $\frac{75}{90}=\frac{5}{6}l$ |
| R | $75\,km/l$ | $\frac{40}{75}=\frac{8}{15}l$ |
| S | $30\,km/l$ | $\frac{10}{30}=\frac{1}{3}l$ |

62. Three friends, R, S and T shared toffee from a bowl. R took 1/3rd of the toffees, but returned four to the bowl. S took 1/4th of what was left but returned three toffees to the bowl. T took half of the remainder but returned two back into the bowl. If the bowl had 17 toffees left, how many toffees-were originally there in the bowl?

(A) 38 (B) 31 (C) 48 (D) 41

Answer: - (C)

Exp: - Let the total number of toffees is bowl e x

R took $\frac{1}{3}$ of toffees and returned 4 to the bowl

$\therefore$ Number of toffees with $R=\frac{1}{3}x-4$

Remaining of toffees in bowl = $\frac{2}{3}x+4$

Number of toffees with S = $\frac{1}{4}\left(\frac{2}{3}x+4\right)-3$

Remaining toffees in bowl = $\frac{3}{4}\left(\frac{2}{3}x+4\right)+4$

Number of toffees with $T=\frac{1}{2}\left(\frac{3}{4}\left(\frac{2}{3}x+4\right)+4\right)+2$

Remaining toffees in bowl = $\frac{1}{2}\left[\frac{3}{4}\left(\frac{2}{3}x+4\right)+4\right]+2$

Given, $\frac{1}{2}\left[\frac{3}{4}\left(\frac{2}{3}x+4\right)+4\right]+2=17 \Rightarrow \frac{3}{4}\left(\frac{2}{3}x+4\right)=27 \Rightarrow x=48$

63. Given that f(y) = | y | / y, and q is any non-zero real number, the value of | f(q) - f(-q) | is

(A) 0 (B) -1 (C) 1 (D) 2

Answer: - (D)

Exp: - Given, $f(y)=\frac{|y|}{y} \Rightarrow f(q)=\frac{|q|}{q}$ ; $f(-q)=\frac{|-q|}{-q}=\frac{-|q|}{q}$

$|f(q)-f(q)|=\frac{|q|}{q}+\frac{|q|}{q}=\frac{2|q|}{q}=2$

64. The sum of n terms of the series 4+44+444+.... is

(A) $(4/81)\left[10^{n+1}-9n-1\right]$ (B) $(4/81)\left[10^{n-1}-9n-1\right]$

(C) $(4/81)\left[10^{n+1}-9n-10\right]$ (D) $(4/81)\left[10^{n}-9n-10\right]$

Answer: - (C)

Exp: - Let S=4 (1 + 11 + 111 + .......) $=\frac{4}{9}(9+99+999+.......)$

$=\frac{4}{9}\left\{(10-1)+\left(10^2-1\right)+\left(10^3-1\right)+.........\right\}$

$=\frac{4}{9}\left\{\left(10+10^2+......10^n\right)-n\right\}=\frac{4}{9}\left\{10\frac{\left(10^n-1\right)}{9}-n\right\}=\frac{4}{81}\left\{10^{n+1}-9n-10\right\}$

65. The horse has played a little known but very important role in the field of medicine. Horses were injected with toxins of diseases until their blood built up immunities. Then a serum was made from their blood. Serums to fight with diphtheria and tetanus were developed this way.

It can be inferred from the passage that horses were

(A) given immunity to diseases (B) generally quite immune to diseases

(C) given medicines to fight toxins (D) given diphtheria and tetanus serums

Answer: - (B)

Exp: - From the passage it cannot be inferred that horses are given immunity as in (A), since the aim is to develop medicine and in turn immunize humans. (B) is correct since it is given that horses develop immunity after some time. Refer "until their blood built up immunities". Even (C) is invalid since medicine is not built till immunity is developed in the horses. (D) is incorrect since specific examples are cited to illustrate and this cannot capture the essence.